Improving Science Classroom Interactions through the Integration of Learners' Socio-cultural Background

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Abstract

The study is based on the constructivist epistemology which assumes that in order to understand an individual's interpretations of reality, one has to understand the particular social contexts within which they operate. The paper addresses the question: How does the integration of learners' practices, experiences and beliefs in science teaching influence classroom interactions? Three Natural Sciences teachers were observed as they integrated their learners' socio-cultural practices, experiences and beliefs into their teaching, through the use of real-life scenarios or authentic problems familiar to learners. The teachers used argumentation activities to assist learners to evaluate the authenticity of their socio-cultural beliefs against scientific knowledge or vice versa. Teachers also used group activities, learners' home languages to explain abstract concepts, and drew on learner experiences from their communities. Learner interactions in class were valuable in fostering a sense of belonging or being valued in the class. Consequently, most learners became active participants during the teaching and learning process. Integration of learners' socio-cultural background may support learners from disadvantaged townships in South Africa in conceptualising science concepts in a comprehensible manner, and allow them to realise the utility value of the school scientific knowledge and skills in their lives.

Keywords: Beliefs; classroom interactions; learners' socio-cultural practices;

INTRODUCTION

Recent curriculum reforms in most countries, South Africa in particular, have called for a pedagogy in which every learner has an opportunity to succeed despite their disadvantaged socio-cultural background. Kelly (2007) raises important issues on what counts as science in different contexts, how this can be accomplished through interactions and, most importantly, who participates in this construction of science knowledge. It should be noted that science taught in decontextualised classrooms has been branded as being disconnected from the learners' socio-cultural background, which Kalolo (2015) described as "a depersonalised science"(p. 39). Despite the call to contextualise science teaching and learning through the use of culturally relevant science pedagogy (Gay, 2010; Ladson-Billing, 2014), there is a dearth of research on how this can be implemented in a science classroom, and the important practical benefits of doing so.

LITERATURE REVIEW

Learners' socio-cultural background

Learners' socio-cultural background refers to their socio-cultural practices and experiences which include norms and values, religion and beliefs, socio-economic and political relations and the learners' indigenous knowledge systems (IKS). Learners are exposed to an in-school cultural socialisation process where instructional practices and learning activities do not reflect their cultural-laden modes of learning and knowing, which Aikenhead (1996) referred to as border crossing into the subculture of science. Teachers should acknowledge and integrate learners' socio-cultural ways of knowing largely informed by their own observations, customs and beliefs, which they bring to the science classroom (Gay, 2002).

Importance of science classroom interactions

Sociocultural theory explains how individuals acquire knowledge from when they interact with others, and also how interactions amongst individuals create collective understanding (Mercer & Howe, 2012). Pioneer socio-cultural theorists such as Barnes (1976) and Cazden (1972) emphasised the important role of classroom talk in increasing learners' engagement in the classroom. High quality teacher-learner and learner-learner interactions can be powerful in developing reasoning and improving academic performance in learners, instead of the routine and habitual teacher seeking confirmatory answers from learners (Mecer & Howe, 2012). As such, when teachers use well-thought out and well-formulated questions that guide learning and use of language as a tool for reasoning, the learning process will be more comprehensible to the learners. It has been found that if teachers use certain interactional strategies more often, learners' participation in class and their educational outcomes are likely to improve (Dawes, 2004; Mercer & Littleton, 2007). In a mathematics classroom Kyriacou and Issitt (2008) also found that learner performance improved when teachers questioning is directed at eliciting learners' reasoning and explanations.

The current study is guided by three theoretical frameworks, socio-cultural theory, social constructivist theory and Scott and Mortimer's dialogical interaction. Socio-cultural perspective propounds how human skills are appropriated by individuals (Säljö, 2009), implying that learners' intellectual achievements and failures do not depend on their efforts and discoveries only, but are also the product of culturally-situated forms of social interaction (Mecer & Howe, 2012). As such the knowledge learners possess is as a result of both individual effort and a creation of shared 'property' of the community members who possess cultural tools in both spoken and written language. In this way, Vygotsky (1978) explained the role of language acquisition and use in transforming learners' thinking. Vygotsky emphasised the importance of social interactions in that when learners are involved in joint activities, they gain new understandings and ways of thinking not only for themselves but also for those they interact with.

Social constructivist theory posits that learners learn best when the content relates to their socio-cultural context, which means learning becomes more effective when related to what learners do, experience and observe in their everyday lives (Vygotsky,1986). The purpose of learning science is to help the learners develop scientific knowledge and an understanding of how science works in real life (Okwara, 2016). Therefore the study is also guided by the social constructivist epistemological view that knowledge is not discovered, but is constructed within the minds of the individuals through social interactions. Social constructivism emphasises the crucial role played by social interactions in the learning environment (Putnam & Borko, 2000). Knowledge construction involves socialisation of individuals into the practices of the communities in which they are embedded, hence the importance of the role of learners' socio-cultural background in science teaching and learning. Different communities have their own ways of validating their knowledge claims. Thus, the study assumes that in order to understand an individual's interpretations of reality, one has to understand the particular social contexts within which they operate. The current paper reports on a study that sought to explore how the integration of learners' practices, experiences and beliefs in science teaching influenced classroom interactions. Classroom interactions are crucial in shaping the teaching and learning process in the classrooms (Aguiar, Mortimer, & Scott, 2010). Effective science teaching recognises the role of learners' prior knowledge and experience, and the social environment during the process of knowledge construction (Mavuru & Ramnarain, 2017).

According to Scott, Mortimer and Aguiar (2006) dialogic discourse in the classroom involves teachers and learners bringing ideas together, exploring and working on them. In this case the dialogic discourse juxtaposes views from everyday knowledge and scientific knowledge. Mortimer and Scott also point that ideas from individuals may also be compared, differentiated and new ideas developed, and in this dialogic discourse learners work together whilst each contribute different views, which are then used to construct a single, satisfactory scientific explanation. Dialogic discourse paves way for different perspectives, and learners become aware of their differences in their views, hence there is always room for acknowledgement and understanding of other people's perspectives in the classroom.

This is unlike authoritative discourse which does not provide an opportunity for learners to share their different viewpoints for exploration but rather the teacher gives attention to the school science viewpoints (Scott, Mortimer & Aguiar, 2006). A point to note is that the teacher can ignore or reshape important ideas and questions from learners. If the teacher perceives learners' ideas as helpful in developing school science, he/she (the teacher) can *seize* and *use* them (which is indicative of authority). Authoritative discourse entails non exploration of different viewpoints put forward, which means teachers can simply ignore learners' contributions.

METHODOLOGY

The study employed a qualitative case study research design. Qualitative research is a naturalistic approach that seeks to understand phenomena in context-specific settings, where the researcher does not manipulate the phenomenon of interest (Patton, 2002), but probes for deeper understanding rather than examining surface features (Johnson, 1995). Previous research studies in education have used case-study research design more to explore the processes and dynamics of practice (Merriam, 1998) in order to shed light on a phenomenon, the process, events, persons or things of interest to the researcher (Gall, Gall & Borg 1996). Therefore, the main characteristic of qualitative research is its focus on the intensive study of specific instances – cases of a phenomenon. For this reason, the current study is a qualitative case-study research that allows an in-depth exploration of classroom practices, using multiple forms of data collection (Creswell, 2005).

Sampling

Three teachers from three township schools located in Johannesburg in South Africa were purposively selected because they had shown interest in the study after a professional development programme on the integration of learners' socio-cultural background. The three Natural Sciences teachers had each taught Grade 9 in the same school for at least three continuous years in which they had an opportunity to interact and familiarise themselves with the community. Therefore the researcher considered them to be knowledgeable about their communities. The teachers had a wide range of teaching experience (4–33 years) and age (26–58 years). They came from different ethnic and religious backgrounds but could speak some of the learners' home languages.

Data collection and analysis

The teachers were observed teaching five lessons each while integrating their learners' socio-cultural practices, experiences and beliefs in teaching Grade 9 learners. Teachers taught different sections of human reproduction, energy and circulatory system. Each lesson lasted for 30 minutes. The Reformed Teaching Observation Protocol (RTOP) (Sawada et al., 2002) was used as an observation tool to capture and assess the extent to which classroom instruction used learner-centred teaching (Lawson et al., 2002). Each teacher was then interviewed twice to seek clarifications on unclear classroom episodes observed.

In analysing the video clips of the lessons, Mortimer and Scott's (2003) framework was used to determine the level of classroom interactions. This framework was used as a tool for analysing the various forms and functions of discursive interactions in the science classrooms. This tool, or analytical framework, is based on a sociocultural view of teaching and learning, and consists of five linked aspects: *Teaching purposes*; *content of the classroom interactions*; *communicative approach*; *patterns of discourse*; *teacher interventions*. In this study focus was only on content of the classroom interactions. Analysis of the discourse of science lessons involved an iterative process of moving backwards and forwards through time, trying to make sense of the episodes as linked chain of interactions. The visual representation of the research design used in this study is shown in Figure 1.

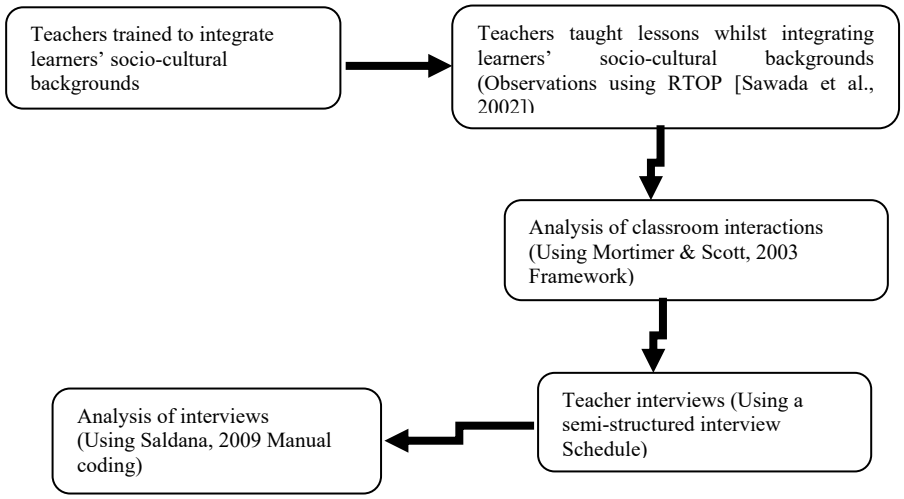

Figure 1: Visual representation of the research design used in this study

FINDINGS

The study answers the research question: How does the integration of learners' socio-cultural practices, experiences and beliefs in Natural Sciences teaching influence classroom interactions? Three key findings are reported on: the teaching strategies teachers used to invoke classroom interactions; the role teachers assumed during classroom interactions; and the benefits drawn from such classroom interactions. Only findings from lesson observations on reproduction are reported. In the different sections classroom discussions, which ensued, are presented as evidence for the kind of classroom discourse portrayed. The interactions in the reported lesson excepts were considered to be more dialogical than authoritative.

Teaching strategies used to invoke classroom interactions

The teachers' integration of learners' socio-cultural background involved the use of real-life scenarios or authentic problems familiar to learners, which connected science with learners' lives. Teachers drew on learner experiences, and allowed learners to sometimes use their home languages in their explanations. Generally in all the three teachers' classes, learner interactions were found to be valuable in fostering a sense of belonging or being valued. Consequently, most learners became active participants during the teaching and learning process.

Teacher 1 provided the following real life scenario when introducing methods of contraception under the topic reproduction: *Some pregnant teenage girls abuse alcohol so that they get more financial grant from the government when they give birth to deformed babies. Is it fair? Is it only impoverished communities which are affected by this problem?*

The learners started discussing and sharing their viewpoints in groups and only one group's reponses are reported.

Learner 1: Mmm the government must intervene, this is murder and robbery
Learner 2: *Mngani* (meaning my friend) you can't judge them you don't know their circumstances
Learner 3: No guys you cannot sympathise with those girls! Condoms are in all clinics.
Learner 4: True think of the baby (foetus) which lost a life.

From the different learners' viewpoints, the teacher asked learners about the opportunities available for these girls to avoid falling pregnant. The learners mentioned abstinence and most of the methods of contraception including some from their traditional beliefs such as jumping over certain shrubs and drinking some concoctions prepared by traditional healers. The issue of abortion was also mentioned as an option and the teacher used this opportunity to discuss ethical and medical issues regarding abortion. Though one learner queried at the end that the problem of poverty still had not been addressed, the concepts that the teacher wanted to teach had already been explored in detail.

During the interviews, the teacher indicated the importance of using real life scenarios and also engaging learners in discussions. For instance during the lesson some learners were quiet and would not even make an effort to share their views. In this case the teacher assumed that it could be: 1. those learners harboured the same sentiments as the teenagers in the scenario and would not tolerate any criticism; 2. probably they were deeply hurt by the realisation that ethically what the teenagers (their sisters) were doing is wrong, or 3. maybe they felt their family situation was exposed in public. Exploration of such issues not only allowed coverage of scientific concepts but also delved into the learners' socio-cultural background and ethical issues which helped learners deal with real-life situations.

In certain instances, the teachers did not bring in scenarios for discussion, but learners raised sexuality issues of concern to get solutions or explanations to some experiences they encounter in their lives. An example is that of a lesson on menstruation under the topic reproduction. Because the teacher (Teacher 2) had created an environment where learners felt 'safe' to share their socio-cultural practices and beliefs related to science, learners utilised this as an opportunity to find health problems they experienced in their bodies. An example of such a classroom excerpt is as follows:

Learner 1: What causes period pains?
Teacher 2: Why are you asking? What do you think is the cause?
Learner 1: There is too much dirt in your body so menstruation is a way of removing the filthy stuff from the body, the body is cleaning itself, my grandmother told me so.
Teacher 2: How does the dirt end up in the body?
Learner 3: Sir, it's coming from some of the junk food we eat.
Learner 4: Mmm... I think the evil spirits could also contribute to this
Learner 5: Do you think one needs to consult with a sangoma (traditional healer) or just go to the clinic?

The discussion went on with the teacher only asking prompt questions and the learners sharing their viewpoints. The responses show that the learners could not distinguish the reproductive system from the digestive system. In explaining the process of menstruation, the teacher went out of his way to display a chart on the digestive system and another on the reproductive system to assist the learners to discern the difference between the two processes. Learners made attempts to validate what they already knew about sexuality against the scientific concepts they had learnt or tried to relate the scientific concepts to their own life experiences. As a result, the teacher pointed out during the interview that in certain instances it was disturbing to note the level of ignorance and misconceptions that learners

display in terms of their reproductive systems. Issues of spirituality were never resolved fully.

In lessons on male reproductive system and circumcision Teacher 3 used argumentation as a teaching strategy to invoke learners to share their socio-cultural practices and how they relate to scientific concepts. The lesson was based on a task that the learners had been given as homework in the previous lesson. It required learners to research on how people with different socio-cultural practices, experiences and beliefs view circumcision and its benefits. The teacher instructed learners to discuss their answers to the question: 'Why is circumcision important in some cultures?' The teacher's questions such as, 'did you ask your parents or any adults at home?' and statements like, 'let's see what you have', are indicative of her commitment to engage learners as members of a learning community and this clearly showed that the lessons were dependent on learners' input.

In explaining the importance of circumcision, learners mentioned different views ranging from traditional and religious to medical aspects that were proffered by different learners, which I thought were attributed to their diverse backgrounds. Based on religion and tradition, learners explained circumcision as a sign of entering manhood and an introduction to adulthood. The learners failed to distinguish circumcision from the traditional practice of initiation which then formed the basis of the argumentation.

Learner1: Circumcision makes me a man, it separates men from boys.
Learner 2: It makes me brave and I can protect my family as the head.

The learners were referring to the Xhosa traditional initiation that takes place in the mountains where boys are circumcised traditionally in their socialisation into manhood.

Learner 3: Boys die in the mountains during initiation so why not just go for circumcision in a hospital.
Learner 4: *Ufana nabafazi*' (meaning you will be like ladies).

Learner 4 was responding to Learner 3 showing that he was incensed that his socio-cultural practice (initiation) was being ridiculed.

Teacher 3: What do you mean?

Since learners were free to air their views, one girl (Learner 5) interjected in response to learner 4's ascertion:

Learner 5: But already they are men when they are born
Learner 3: My body is still clean, didn't you hear about the campaigns on radio and television?

During these discussions, an emotional boy stood up and vehemently stressed the need for every man to be trained to be tough and not to be treated like women, thereby supporting an earlier claim by the other learner that those who undergo medical circumcision are weak as men. In fact, he was defending the way boys are treated in an initiation school in a bid to counter the earlier assertion that the initiation ceremonies were bent on cruelty.

From these results of the dialogical discourses in the classes, teachers' use of prompt and open-ended questions helped them to elicit learners' pre-instructional knowledge as the learners tried to answer each other's questions. Science teaching was linked to everyday real-life situations to which those scientific concepts were related. In this way, teachers managed to identify gaps which learners' social-cultural beliefs and practices could create between what they teach and what is learnt. At the same time such teaching approaches enabled the

teachers to tackle challenges posed by the belief systems learners held, which may interfere in the learners' understanding of science concepts. Most importantly teachers managed to help learners distinguish scientific knowledge from their worldviews and to be able to deduce any connections. In this study argumentation and cooperative groups are referred to as inclusive teaching strategies because they stimulated debates and discussions among learners. Argumentation has been found to be an appropriate learning strategy teachers can employ as 'the goal of science must not only be the mastery of scientific concepts but also learning how to engage in scientific discourse' (Bricker & Bell, 2009). A clash of knowledge domains, the culture of science and the learners' worldviews, was evident. The teacher's patience allowed more vibrant exploration of the science concepts, despite the divergent ideas brought in by learners.

The role teachers assumed during classroom interactions

Because most learners were no longer in touch with their extended families due to urban migration, teachers adopted new roles as they incorporated learners' socio-cultural practices, experiences and beliefs, which Irvine (2003) referred to as parental/surrogate roles. Teachers acted as facilitators or guides as they did not interrupt discussions, but instead waited and used probing questions to provide focus to the discussions, nor did they readily provide the information for learners to answer the questions.

These class discussions encouraged learners to evaluate or validate their beliefs and practices against science knowledge and vice versa. The learners challenged each other's reasoning and in turn helped and supported each other in reaching group conclusions. Through these interactions, learning and development can take place. The teachers managed class discussions in such a way that this allowed tolerance for cultural diversity and divergent thinking among the learners. There were, however, insinuations of socio-cultural stereotypes in the responses made by some learners. In addition more time were spent in classroom debates, discussions and at times comprised completion of learning areas within planned time.

The benefits drawn from such classroom interactions

In all the three teachers' classes, learner interactions in class were found to be valuable in fostering a sense of belonging or being valued. Consequently, most learners became active participants during the teaching and learning process. Class and group discussions enabled learners to express ideas and make connections between a real-life scenario and scientific concepts, thus enabling the teachers to elicit learners' pre-instructional knowledge, some of which, if ignored, could have created barriers to the understanding of new concepts. Analysis of interviews showed teachers acknowledging the importance of learner interactions in the science classroom due to integration of their socio-cultural background. The following are some of what the three teachers said about their classroom interactions:

Teacher 1: It helps me on how to structure my teaching with the learners in mind. Yes l could just easily follow the textbook but unfortunately learners will not come out in the open to share what they know and how they feel about the concept.

Teacher 2: Learners presented issues about their beliefs that made me discuss certain science concepts regarding the topic that I had not planned for.

Teacher 3: Talking to learners makes you realise how much they know which may even surprise you. I now believe in a way learners should lead the lesson and not the other way round.

Classroom interactions (learner-learner and teacher-learner) formed important learning moments in that as learners discussed their questions and ideas, they also developed effective communication skills. The classroom discussions were very interactive and dialogic (Scott &

Mortimer, 2003). In addition, this allowed the teachers to assess the depth of the learning process and also to identify potential misconceptions harboured by learners. From the lessons, it can be deduced that the teachers' task was mainly to provide scaffolding by giving direction and instructions, comments and feedback to the learners which made them acquire the intended concepts and skills.

Science concepts became more meaningful as they related to learners' daily lives and experiences. These classroom interactions created positive learning environments, which acted as a critical learner motivating tool, thereby making learners feel being part of the learning communities (Weinstein et al. 2006). In that way, learners also got more opportunities to model authentic scientific tasks which increased their scientific thinking (Abd-El Khalick & Lederman, 2000). This is in line with research which shows that learner-learner interactions increase both the understanding of key concepts (Smith et al., 2009) and problem-solving abilities (Hake, 1997).

CONCLUSIONS

The research findings show how learners' socio-cultural background influenced teachers to employ social constructivist teaching approaches that fully engaged learners in the science classrooms. Integration of socio-cultural practices, experiences and beliefs in science teaching increased learner participation in class. This could be because learners were involved in discussions of authentic life situations and also communicating their experiences related to the content under discussion. Science concepts became more meaningful as they related to learners' evryday life experiences.

Implications for future research

There are important questions that arise from the study which require further exploration if meaningful integration of learners' socio-cultural background is to be done in the science classroom. For instance: whose beliefs, practices and experiences should the teachers focus on considering the multicultural nature and diversity in the science classroom? Are the teachers familiar with the different learners' socio-cultural background? How do the teachers deal with their own beliefs, practices and experiences that conflict with those of the learners?

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